Appendix K

Modeled Activity Assumptions and Emissions Controls

1.0. INTRODUCTION

In Appendix K, we summarize the activity assumptions made in estimating emissions for the CD-C Project Emissions Inventory. The origin of the emission factors and speciation used is noted, as well as fuel type and the activity surrogate used to calculate field-wide emissions. We also show the emissions control measures that were modeled for the CD-C Project. Detailed information on CD-C Project emissions calculations and are provided in Appendix H.

Source Category	Activity Data Provided By Operator	Emission Factors/Speciation			Fuel Type	Engine Technology or Control Device	Type of Control Applied	Control Applied to Pollutants	Activity Surrogate
		Criteria Air Pollutants	Greenhouse Gases	Hazardous Air Pollutants					
Well Pad Const Equip (diesel ICE)	Engine Type, Number of Units, Fuel Type, Engine Technology, Rated Horsepower, Time Used, Load Factor	Emission factors from EPA Federal Diesel Engine Standards. Where EPA Federal emission factors were not available, used EPA NONROAD model fully deteriorated Tier emission factors.	CO_2 and CH_4 emission factors based on EPA NONROAD model methodology and N_2O emission factor from The Climate Registry, General Reporting Protocol v1.1, Table 13.6.	SPECIATE4, Profile 4674	Diesel	Tier 1	Change in fuel sulfur content	SOx	Well Pads
Completion Equipment (diesel ICE)	Engine Type, Number of Units, Fuel Type, Rated Horsepower, Time Used, Load Factor	Emission factors from EPA Federal Diesel Engine Standards. Where EPA Federal emission factors were not available, used EPA NONROAD model fully deteriorated Tier emission factors.	CO_2 and CH_4 emission factors based on EPA NONROAD model methodology and N_2O emission factor from The Climate Registry, General Reporting Protocol v1.1, Table 13.6.	SPECIATE4, Profile 4674	Diesel	Due to lack of information conservatively assumed that all equipment uses Tier 0 engines.	Change in fuel sulfur content	SOx	Spuds
Construction Traffic, Road and Well pad	Vehicle Type (Light or Heavy), Mean Vehicle Speed, Round Trip Off-Road Trip Distance, Number of Round Trips Per Well	Emission factors estimated based on EPA MOVES model runs.	Emission factors estimated based on EPA MOVES model runs.	Heavy Duty Vehicles: EPA profiles based on CRC E-55/E-59 Study Light Duty Vehicles: Profiles provided by EPA and MOVES	MOVES default fuel fractions for each vehicle type	-	Change in emissions due to fleet turnover	NOx, CO, CO_2, VOC, SOx, PM_{10}, $PM_{2.5}$, CH_4, N_2O	Well Pads
Construction Traffic, Road and Well pad-Fugitive Dust		Emissions estimated using the equation from EPA,AP-42, Section 13.2.2 Unpaved Roads (11/06). Assumed Heavy truck weight of 70000 pounds, assumed Light truck weight of 7000 lbs.	N/A	N/A	N/A	-	Watering	Fugitive Road Dust PM_{10}, Fugitive Road Dust $PM_{2.5}$	Well Pads

Source Category	Activity Data Provided By Operator	Emission Factors/Speciation			Fuel Type	Engine Technology or Control Device	Type of Control Applied	Control Applied to Pollutants	Activity Surrogate
		Criteria Air Pollutants	Greenhouse Gases	Hazardous Air Pollutants					
Drilling Equipment (diesel ICE)	Engine Type, Number of Units, Fuel Type, Engine Technology, Rated Horsepower Time Used, Load Factor, Brake Specific Fuel Consumption	Emission factors from EPA Federal Diesel Engine Standards. Where EPA Federal emission factors were not available, used EPA NONROAD model fully deteriorated Tier emission factors.	CO_2 and CH_4 emission factors based on EPA NONROAD model methodology and N_2O emission factor from The Climate Registry, General Reporting Protocol v1.1, Table 13.6.	SPECIATE4, Profile 4674	Diesel	Drilling by three diesel 1476 HP IC engines and one diesel 125 HP IC engine. All diesel engines, assumed to be 50% Tier 0 and 50% Tier 2 until 2018. From 2019 on, all engines assumed to be 100% Tier 2.	Change in fuel sulfur content and Change in emissions due to cleaner engine technology	NOx, CO, CO_2, VOC, SOx, PM_{10}, $PM_{2.5}$, PM_filt, PM_cond, CH_4, N_2O	Spuds
Drilling Traffic	Vehicle Type (Light or Heavy), Mean Vehicle Speed, Round Trip Off-Road Trip Distance, Number of Round Trips Per Spud	Emission factors estimated based on EPA MOVES model runs.	Emission factors estimated based on EPA MOVES model runs.	Heavy Duty Vehicles: EPA profiles based on CRC E-55/E-59 Study Light Duty Vehicles: EPA and MOVES Profiles	MOVES default fuel fractions for each vehicle type	-	Change in emissions due to fleet turnover	NOx, CO, CO_2, VOC, SOx, PM_{10}, $PM_{2.5}$, CH_4, N_2O	Spuds
Drilling Traffic-Fugitive Dust		Emissions estimated using the equation from EPA,AP-42, Section 13.2.2 Unpaved Roads (11/06). Assumed Heavy truck weight of 70000 pounds, assumed Light truck weight of 7000 lbs.	N/A	N/A	N/A	-	Watering	Fugitive Road Dust PM_{10}, Fugitive Road Dust $PM_{2.5}$	Spuds

Source Category	Activity Data Provided By Operator	Emission Factors/Speciation			Fuel Type	Engine Technology or Control Device	Type of Control Applied	Control Applied to Pollutants	Activity Surrogate
		Criteria Air Pollutants	Greenhouse Gases	Hazardous Air Pollutants					
Completion Traffic	Vehicle Type (Light or Heavy), Mean Vehicle Speed, Round Trip Off-Road Trip Distance, Number of Round Trips Per Spud	Emission factors estimated based on EPA MOVES model runs.	Emission factors estimated based on EPA MOVES model runs.	Heavy Duty Vehicles: EPA profiles based on CRC E-55/E-59 Study Light Duty Vehicles: EPA and MOVES profiles	MOVES default fuel fractions for each vehicle type	-	Change in emissions due to fleet turnover	NOx, CO, CO_2, VOC, SOx, PM_{10}, $PM_{2.5}$, CH_4, N_2O	Spuds
Completion Traffic- Fugitive Dust		Emissions estimated using the equation from EPA,AP-42, Section 13.2.2 Unpaved Roads (11/06). Assumed Heavy truck weight of 70000 pounds, assumed Light truck weight of 7000 lbs.	N/A	N/A	N/A	-	Watering	Fugitive Road Dust PM_{10}, Fugitive Road Dust $PM_{2.5}$	Spuds
Completion Venting	Gas Composition Analysis, Gas Flow, Heat Content of Flared gas , Green Completion and Conventional Completion Fraction, Fraction of Gas Flared, Fraction of Gas Vented, Fraction of Flared Gas Controlled per Well, Volume of Gas Vented	Zero uncontrolled venting emissions due to flaring and green completion controls.	Zero uncontrolled venting emissions due to flaring and green completion controls.	Wamsutter Wet Gas Composition	-	-	96% of Gas to Green Completions and 4% of Gas will be Flared	VOC, CO_2, CH_4	Spuds

Source Category	Activity Data Provided By Operator	Emission Factors/Speciation			Fuel Type	Engine Technology or Control Device	Type of Control Applied	Control Applied to Pollutants	Activity Surrogate
		Criteria Air Pollutants	Greenhouse Gases	Hazardous Air Pollutants					
Completion Flaring	Heat Content of Flared Gas, Wet Gas Composition, Fraction of Gas Flared, Volume Flared per day, Volume Flared per Spud, Average Days per Completion	NOx, and CO emission factors were obtained from EPA AP-42, Table 13.5-1. Emission Factors for Flare Operations (9/95). VOC emission factor based on the fraction of THC as VOC and THC emission factor from EPA AP-42, Table 13.5-1. Emission Factors for Flare Operations (9/95).	CO_2 emissions are based on the estimation of CO_2 potential of the entire gas from the wet gas composition. N_2O emission factor from API Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Natural Gas Industry, 2009 Table 4-11, GHG Emission Factors for Gas Flares in Developed Countries. CH_4 emission factor based on the fraction of THC as CH_4 and THC emission factor from EPA AP-42, Table 13.5-1. Emission Factors for Flare Operations (9/95).	SPECIATE4, Profile 0051	Natural Gas	-	N/A	-	Spuds
Well Pad and Access Road Construction-Fugitive Dust	Equipment Type, Number of Units, Time Used per Pad	Fugitive Construction Dust PM_{10} and $PM_{2.5}$ emissions were estimated using equations from EPA, AP-42 Table 11.9-1 for Bulldozing Overburden Emissions, Western Surface Coal Mining. Parameters used in emission equations were from EPA AP-42, Table 11.9-3.	N/A	N/A	N/A	-	Watering	Fugitive Dust PM_{10}, Fugitive Dust $PM_{2.5}$	Well Pads
Construction Wind Erosion-Fugitive Dust	Disturbed Area per Well Pad	Fugitive Wind Erosion Dust PM_{10} and $PM_{2.5}$ emissions were estimated using methodology described in EPA, AP-42 Section 13.2.5.3. Exposed surface type assumed to be flat. 2007, 2008, and 2009 Wind Speed data from the Wamsutter Station.	N/A	N/A	N/A	-	None	-	Well Pads

Source Category	Activity Data Provided By Operator	Emission Factors/Speciation			Fuel Type	Engine Technology or Control Device	Type of Control Applied	Control Applied to Pollutants	Activity Surrogate
		Criteria Air Pollutants	Greenhouse Gases	Hazardous Air Pollutants					
Workover Equip (diesel ICE)	Engine Type, Number of Units, Fuel Type, Engine Technology, Rated Horsepower, Time Used, Workover Equipment Use Frequency, Workover Equipment Yearly Requirement, Load Factor	Emission factors from EPA Federal Diesel Engine Standards. Where EPA Federal emission factors were not available, used EPA NONROAD model fully deteriorated Tier 0 emission factors.	CO_2 and CH_4 emission factors based on EPA NONROAD model methodology and N_2O emission factor from The Climate Registry, General Reporting Protocol v1.1, Table 13.6.	SPECIATE4, Profile 4674	Diesel	Tier 0	Change in fuel sulfur content	SOx	Active Well Counts
Workover Rig Traffic	Vehicle Type (Light or Heavy), Mean Vehicle Speed, Round Trip Off-Road Trip Distance, Number of Round Trips Per Well	Emission factors estimated based on EPA MOVES model runs.	Emission factors estimated based on EPA MOVES model runs.	Heavy Duty Vehicles: EPA profiles based on CRC E-55/E-59 Study Light Duty Vehicles: EPA and MOVES profiles	MOVES default fuel fractions for each vehicle type	-	Change in emissions due to fleet turnover	NOx, CO, CO_2, VOC, SOx, PM_{10}, $PM_{2.5}$, CH_4, N_2O	Active Well Counts
Workover Rig Traffic- Fugitive Dust		Emissions estimated using the equation from EPA,AP-42, Section 13.2.2 Unpaved Roads (11/06). Assumed Heavy truck weight of 70000 pounds, assumed Light truck weight of 7000 lbs.	N/A	N/A	N/A	-	Watering	Fugitive Road Dust PM_{10}, Fugitive Road Dust $PM_{2.5}$	Active Well Counts

Source Category	Activity Data Provided By Operator	Emission Factors/Speciation			Fuel Type	Engine Technology or Control Device	Type of Control Applied	Control Applied to Pollutants	Activity Surrogate
		Criteria Air Pollutants	Greenhouse Gases	Hazardous Air Pollutants					
Heaters	Equipment Type, Heat Input, Local Heating Value, Number of Units, Time Used Per Unit, Heating Cycle Fraction	Emission factors from EPA, AP-42, Tables 1.4-1 Emission Factors for Nitrogen Oxides and Carbon Monoxide from Natural Gas Combustion and 1.4-2 Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion.	Emission factors from EPA, AP-42, Table 1.4-2 Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion.	SPECIATE4, Profile 0003	Natural Gas	-	None	-	Active Well Counts
Fugitives	Gas Composition Analysis, Component Counts by Media Type	VOC emissions estimated using TOC emission factor (kg/hr/component) from EPA, 1995 AP-42 Table 2-4. "Oil and Gas Production Operations Average Emission Factors", and VOC/THC weight fraction from gas composition analysis.	To obtain CO_2 and CH_4 emissions, the CO_2 and CH_4 to VOC weight ratio from the natural gas composition were applied to VOC emissions.	Wamsutter Produced Gas Composition and Wamsutter Fugitive Post Flash Gas Composition	-	-	None	-	Active Well Counts
Pneumatic Devices	As per Operator's input there will be all "no bleed" devices and hence zero emissions from this category								
Pneumatic Pump	Type of Pump, Gallons Used per Pump, SCF/Gallon , Number of Pumps, Days of Use per Year, SCF/Pump/Minute, Vented Volume Per Year, Molar Composition of Sales Gas	Zero uncontrolled venting emissions due to flaring control.	Zero uncontrolled venting emissions due to flaring control.	Wamsutter Produced Gas Composition	-	Flare	WYDEQ BACT	VOC, CH_4, CO_2	Active Well Counts
Dehydrator Venting	Average Gas Production Per Year Per Well, Number of dehydrators per Well, Regenerator Overhead Vent Stream Composition	Zero uncontrolled venting emissions due to flaring control.	Zero uncontrolled venting emissions due to flaring control.	Regenerator Overhead Vent Stream Composition	-	Flare	WYDEQ BACT	VOC, CH_4, CO_2	Active Well Counts

Source Category	Activity Data Provided By Operator	Emission Factors/Speciation			Fuel Type	Engine Technology or Control Device	Type of Control Applied	Control Applied to Pollutants	Activity Surrogate
		Criteria Air Pollutants	Greenhouse Gases	Hazardous Air Pollutants					
Tank Loadout (vapor losses)	Type of Petroleum Liquid Loaded, Saturation Factor, True Vapor Pressure of Liquid Loaded , Molecular Weight of Vapors , Temperature of Bulk Liquid , Mode of Operation, Capacity of Truck	VOC loading losses determined using EPA,AP-42, Section 5.2.2.1.1 Equation 1.	To obtain CO_2 and CH_4 emissions, the CO_2 and CH_4 to VOC weight ratio from the natural gas composition were applied to VOC emissions.	Wamsutter Condensate Composition (Post Flash)	-	-	None	-	Annual Condensate Production
Well Venting	VOC Venting Emission Factor, Wet Gas Composition	VOC emission factor from operator .	To obtain CO_2 and CH_4 emissions, the CO_2 and CH_4 to VOC weight ratio from the natural gas composition were applied to VOC emissions.	Wamsutter Wet Gas Composition	-	-	None	-	Active Well Counts
Production Traffic	Vehicle Type (Light or Heavy), Mean Vehicle Speed, Round Trip Off-Road Trip Distance, Number of Round Trips Per Well or Central Facilities	Emission factors estimated based on EPA MOVES model runs.	Emission factors estimated based on EPA MOVES model runs.	Heavy Duty Vehicles: EPA profiles based on CRC E-55/E-59 Study Light Duty Vehicles: EPA and MOVES profiles	MOVES default fuel fractions for each vehicle type	-	Change in emissions due to fleet turnover	NOx, CO, CO_2, VOC, SOx, PM_{10}, $PM_{2.5}$, CH_4, N_2O	Active Well Counts, None for Central Facilities
Production Traffic- Fugitive Dust		Emissions estimated using the equation from EPA,AP-42, Section 13.2.2 Unpaved Roads (11/06). Assumed Heavy truck weight of 70000 pounds, assumed Light truck weight of 7000 lbs.	N/A	N/A	N/A	-	Watering	Fugitive Road Dust PM_{10}, Fugitive Road Dust $PM_{2.5}$	Active Well Counts, None for Central Facilities

Source Category	Activity Data Provided By Operator	Emission Factors/Speciation			Fuel Type	Engine Technology or Control Device	Type of Control Applied	Control Applied to Pollutants	Activity Surrogate
		Criteria Air Pollutants	Greenhouse Gases	Hazardous Air Pollutants					
Condensate Tank Flashing Losses	Uncontrolled VOC, CH_4 emission factors	Zero uncontrolled venting emissions due to flaring control.	Zero uncontrolled venting emissions due to flaring control.	Wamsutter Condensate Composition (Flash)	-	Flare	WYDEQ BACT	VOC, CH_4, CO_2	Annual Condensate Production
Condensate Tank Working Losses	Uncontrolled VOC, CH_4 emission factors	Zero uncontrolled venting emissions due to flaring control.	Zero uncontrolled venting emissions due to flaring control.	Wamsutter Condensate Composition (Post Flash)	-	Flare	WYDEQ BACT	VOC, CH_4, CO_2	Total Turnovers per Year
Condensate Tank Breathing Losses	Uncontrolled VOC, CH_4 emission factors	Zero uncontrolled venting emissions due to flaring control.	Zero uncontrolled venting emissions due to flaring control.	Wamsutter Condensate Composition (Post Flash)	-	Flare	WYDEQ BACT	VOC, CH_4, CO_2	Active Well Counts
Production Flaring	Total Process Gas, Gas Composition Analysis	NOx, and CO emission factors were obtained from EPA AP-42, Table 13.5-1. Emission Factors for Flare Operations (9/95). VOC emission factor based on the fraction of THC as VOC and THC emission factor from EPA AP-42, Table 13.5-1. Emission Factors for Flare Operations (9/95).	CO_2 emissions based on CO_2 potential of the entire gas based on gas composition. N_2O emission factor from API Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Natural Gas Industry, 2009 Table 4-11, GHG Emission Factors for Gas Flares in Developed Countries. CH_4 emission factor based on the fraction of THC as CH_4 and THC emission factor from EPA AP-42, Table 13.5-1. Emission Factors for Flare	SPECIATE4, Profile 0051	Natural Gas	-	-	-	Annual Condensate Production, Total Turnovers per Year, Active Well Counts

Source Category	Activity Data Provided By Operator	Emission Factors/Speciation			Fuel Type	Engine Technology or Control Device	Type of Control Applied	Control Applied to Pollutants	Activity Surrogate
		Criteria Air Pollutants	Greenhouse Gases	Hazardous Air Pollutants					
			Operations (9/95).						
Compressor Station	Existing Capacity , Capacity to be Added, Additional Horsepower Needed , Compressor Type - Reciprocating or Turbines	Turbines: All criteria pollutants emission factors except NOx, VOC, and CO were from EPA, AP-42, Table 3.1-2a, Emission Factors for Criteria Pollutants and Greenhouse Gasses from Stationary Gas Turbines. The NOx, VOC and CO emission factors were obtained from minimum emission factors provided in existing sources by operator.	Turbines: CO_2 and N_2O emission factors from EPA, AP-42, Table 3.1-2a, Emission Factors for Criteria Pollutants and Greenhouse Gases from Stationary Gas Turbines . CH_4 from SPECIATE PROFILE.	SPECIATE4, Profile 0007	Natural Gas	As per the operator, additional 24,936 horsepower is required. Assumed 2.7% of horsepower added is reciprocating engines and 97.3% of horsepower added is turbines. These fractions were assumed based on the fraction of horsepower by engine type at existing stations.	None	-	None
		Reciprocating Engines: All criteria pollutants emission factors except NOx, VOC and CO were from Table3-2.3, Uncontrolled Emission Factors for 4-Stroke Rich-burn Engines. Assumed BACT level NOx and CO emission factors and VOC emission factor was obtained from minimum emission factors provided in existing sources by	Reciprocating Engines: CO_2 emission factor from Table3-2.3, Uncontrolled Emission Factors for 4-Stroke Rich-burn Engines. CH_4 from SPECIATE PROFILE. N_2O emission factor from API Compendium of greenhouse gas emissions methodologies for the oil and natural gas industry,2009 .	SPECIATE4, Profile 1001	Natural Gas		BACT was assumed to limit NOx and CO emissions.	NOx , CO	

Source Category	Activity Data Provided By Operator	Emission Factors/Speciation			Fuel Type	Engine Technology or Control Device	Type of Control Applied	Control Applied to Pollutants	Activity Surrogate
		Criteria Air Pollutants	Greenhouse Gases	Hazardous Air Pollutants					
		operator.							
Gas Plant	Total Engine Capacity, Existing Plant Capacity , NOx, CO and VOC Emissions for the Existing Plant	Turbines: All criteria pollutants emission factors except NOx, VOC, and CO were from EPA, AP-42, Table 3.1-2a, Emission Factors for Criteria Pollutants and Greenhouse Gasses from Stationary Gas Turbines. The NOx, VOC and CO emission factors were obtained from minimum emission factors provided in existing sources by operator.	Turbines: CO_2 and N_2O emission factors from EPA, AP-42, Table 3.1-2a, Emission Factors for Criteria Pollutants and Greenhouse Gases from Stationary Gas Turbines . CH_4 from SPECIATE PROFILE.	SPECIATE4, Profile 0007	Natural Gas	As per the operator, additional 760 mmscfd capacity is required to handle the additional gas volumes anticipated from the proposed wells.	None	-	None
		Reciprocating Engines: All criteria pollutants emission factors except NOx, VOC and CO were from Table3-2.3, Uncontrolled Emission Factors for 4-Stroke Rich-burn Engines. Assumed BACT level NOx and CO emission factors and VOC emission factor was obtained from minimum emission factors provided in existing sources by operator.	Reciprocating Engines: CO_2 emission factor from Table3-2.3, Uncontrolled Emission Factors for 4-Stroke Rich-burn Engines. CH_4 from SPECIATE PROFILE. N_2O emission factor from API Compendium of greenhouse gas emissions methodologies for the oil and natural gas industry,2009 .	SPECIATE4, Profile 1001	Natural Gas		BACT was assumed to limit NOx and CO emissions.	NOx , CO	

Source Category	Activity Data Provided By Operator	Emission Factors/Speciation			Fuel Type	Engine Technology or Control Device	Type of Control Applied	Control Applied to Pollutants	Activity Surrogate
		Criteria Air Pollutants	Greenhouse Gases	Hazardous Air Pollutants					
		Heaters/Process/Duct Burner: All criteria pollutants except NOx, VOC and CO emission factors were from EPA AP-42, Table 1.4-2 Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion. The NOx, CO and VOC emission factor were obtained from minimum or average emission factors provided in existing sources by operator.	Heaters/Process/Duct Burner: CO_2, CH_4 and N_2O Emission Factors from EPA AP-42 Table 1.4-2 Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion.	SPECIATE4, Profile 0003	Natural Gas		None	-	
		Flaring: NOx, VOC and CO emissions of the existing plant were scaled by the ratio of new plant capacity to existing plant capacity.	Flaring: $CO_2/CH_4/N_2O$ to NOx emission factor ratio was applied to NOx emissions to obtain CO_2, CH_4 and N_2O emissions. The NOx, CO_2 and CH_4 emission factors were obtained from EPA AP-42, Table 13.5-1. Emission Factors for Flare Operations. N_2O emission factor from API Compendium of greenhouse gas emissions methodologies for the oil and natural gas industry,2009 Table 4-11, GHG Emission Factors for Gas Flares in Developed Countries.	SPECIATE4, Profile 0051	Natural Gas				
		Fugitives: Operator has assumed that emissions do not scale by plant capacity. It was assumed that the existing and new plant will have LDAR.	Fugitives: To obtain CO_2 and CH_4 emissions, CO_2 and CH_4 to VOC weight ratios from the gas composition analysis were applied to VOC emissions.	Wamsutter Produced Gas Composition	-				

Source Category	Activity Data Provided By Operator	Emission Factors/Speciation			Fuel Type	Engine Technology or Control Device	Type of Control Applied	Control Applied to Pollutants	Activity Surrogate
		Criteria Air Pollutants	Greenhouse Gases	Hazardous Air Pollutants					
Evaporation Ponds	Emissions (tpy) based on Water 9 model Output, Produced Water Working and Breathing Analysis	Assumed that the HPAs estimates from Water 9 model output to be the only VOCs emitted from the ponds.	To obtain CO_2 and CH_4 emissions, CO_2 and CH_4 to VOC weight ratios from the gas composition analysis were applied to VOC emissions.	Produced Water Working and Breathing Analysis	-	-	None	-	Active Well Counts

Source Category	Control Percentage (%)						Uncontrolled Case Engine Technology or control	Uncontrolled Case Type of Control
	NOx	CO	VOC	PM_{10}	$PM_{2.5}$	SOx		
Well Pad Const Equip (diesel ICE)	0%	0%	0%	0%	0%	Prior to 2010 - 0% 2010 - 53% 2011 - 91% After 2011 - 97%	no change	fuel sulfur content changes removed
Completion Equipment (diesel ICE)	0%	0%	0%	0%	0%	Prior to 2010 - 0% 2010 - 53% 2011 - 91% After 2011 - 97%	no change	fuel sulfur content changes removed
Construction Traffic, Road and Well pad	Control percentage in the selected years Heavy Duty / Light Duty 2010 10% 5% 2015 51% 33% 2020 74% 54% 2025 84% 66% 2030 88% 73% 2037 89% 77%	Control percentage in the selected years Heavy Duty / Light Duty 2010 4% 3% 2015 28% 22% 2020 44% 34% 2025 52% 41% 2030 56% 46% 2037 60% 50%	Control percentage in the selected years Heavy Duty / Light Duty 2010 3% 4% 2015 38% 33% 2020 62% 52% 2025 76% 65% 2030 83% 73% 2037 87% 78%	Control percentage in the selected years Heavy Duty / Light Duty 2010 7% 6% 2015 53% 35% 2020 79% 54% 2025 90% 63% 2030 94% 69% 2037 96% 72%	Control percentage in the selected years Heavy Duty / Light Duty 2010 7% 6% 2015 53% 36% 2020 79% 54% 2025 90% 64% 2030 94% 69% 2037 96% 73%	Control percentage in the selected years Heavy Duty / Light Duty 2010 45% 11% 2015 76% 30% 2020 77% 36% 2025 77% 40% 2030 77% 42% 2037 78% 44%	-	Emission rates held constant at 2009 levels
Construction Traffic, Road and Well pad-Fugitive Dust	0%	0%	0%	50%	50%	0%	-	Removed watering control
Drilling Equipment (diesel ICE)	Control percentage for diesel ICE 1476 Hp and 125 Hp engines 1476 HP / 125 HP Until 2018 0% 0% After 2018 31% 29%	Control percentage for diesel ICE 1476 Hp and 125 Hp engines 1476 HP / 125 HP Until 2018 0% 0% After 2018 10% 8% increase	Control percentage for diesel ICE 1476 Hp and 125 Hp engines 1476 HP / 125 HP Until 2018 0% 0% After 2018 50% 49%	Control percentage for diesel ICE 1476 Hp and 125 Hp engines 1476 HP / 125 HP Until 2018 0% 0% After 2018 55% 39%	Control percentage for diesel ICE 1476 Hp and 125 Hp engines 1476 HP / 125 HP Until 2018 0% 0% After 2018 55% 39%	Control percentage for diesel ICE 1476 Hp and 125 Hp engines 1476 HP / 125 HP Prior to 2010 0% 0% 2010 53% 53% 2011 91% 91% After 2011 97% 97%	Drilling by 3 diesel 1476 HP IC engines and 1 diesel 125 HP IC engine. 50% of diesel IC engines assumed Tier 0 engines and 50% Tier 2 engines.	fuel sulfur content changes and use of newer technology engines in 2019+ removed
Drilling Traffic	Control percentage in the selected years Heavy Duty / Light Duty 2010 10% 5% 2015 51% 33% 2020 74% 54% 2025 84% 66% 2030 88% 73% 2037 89% 77%	Control percentage in the selected years Heavy Duty / Light Duty 2010 4% 3% 2015 28% 22% 2020 44% 34% 2025 52% 41% 2030 56% 46% 2037 60% 50%	Control percentage in the selected years Heavy Duty / Light Duty 2010 3% 4% 2015 38% 33% 2020 62% 52% 2025 76% 65% 2030 83% 73% 2037 87% 78%	Control percentage in the selected years Heavy Duty / Light Duty 2010 7% 6% 2015 53% 35% 2020 79% 54% 2025 90% 63% 2030 94% 69% 2037 96% 72%	Control percentage in the selected years Heavy Duty / Light Duty 2010 7% 6% 2015 53% 36% 2020 79% 54% 2025 90% 64% 2030 94% 69% 2037 96% 73%	Control percentage in the selected years Heavy Duty / Light Duty 2010 45% 11% 2015 76% 30% 2020 77% 36% 2025 77% 40% 2030 77% 42% 2037 78% 44%	-	Emission rates held constant at 2009 levels

Source Category	Control Percentage (%)						Uncontrolled Case Engine Technology or control	Uncontrolled Case Type of Control
	NOx	CO	VOC	PM_{10}	$PM_{2.5}$	SOx		
Drilling Traffic-Fugitive Dust	0%	0%	0%	50%	50%	0%	-	Removed watering control
Completion Traffic	Control percentage in the selected years Heavy Duty / Light Duty 2010 10% / 5% 2015 51% / 33% 2020 74% / 54% 2025 84% / 66% 2030 88% / 73% 2037 89% / 77%	Control percentage in the selected years Heavy Duty / Light Duty 2010 4% / 3% 2015 28% / 22% 2020 44% / 34% 2025 52% / 41% 2030 56% / 46% 2037 60% / 50%	Control percentage in the selected years Heavy Duty / Light Duty 2010 3% / 4% 2015 38% / 33% 2020 62% / 52% 2025 76% / 65% 2030 83% / 73% 2037 87% / 78%	Control percentage in the selected years Heavy Duty / Light Duty 2010 7% / 6% 2015 53% / 35% 2020 79% / 54% 2025 90% / 63% 2030 94% / 69% 2037 96% / 72%	Control percentage in the selected years Heavy Duty / Light Duty 2010 7% / 6% 2015 53% / 36% 2020 79% / 54% 2025 90% / 64% 2030 94% / 69% 2037 96% / 73%	Control percentage in the selected years Heavy Duty / Light Duty 2010 45% / 11% 2015 76% / 30% 2020 77% / 36% 2025 77% / 40% 2030 77% / 42% 2037 78% / 44%	-	Emission rates held constant at 2009 levels
Completion Traffic-Fugitive Dust	0%	0%	0%	50%	50%	0%	-	Removed watering control
Completion Venting	0%	0%	Zero vented emissions are estimated due to flaring control. 100% of the gas stream is assumed combusted in the flare; flare combustion VOC emissions are estimated to be approximately 1% of the VOC emissions if no controls were implemented.	0%	0%	0%	-	Assumed that all completion emission are vented to the atmosphere

Source Category	Control Percentage (%)						Uncontrolled Case Engine Technology or control	Uncontrolled Case Type of Control
	NOx	CO	VOC	PM_{10}	$PM_{2.5}$	SOx		
Completion Flaring	N/A	N/A	N/A	N/A	N/A	N/A	-	-
Well Pad and Access Road Construction - Fugitive Dust	0%	0%	0%	50%	50%	0%	-	Removed watering control
Construction Wind Erosion- Fugitive Dust	0%	0%	0%	0%	0%	0%	-	no change
Workover Equip (diesel ICE)	0%	0%	0%	0%	0%	Prior to 2010 - 0% 2010 - 53% 2011 - 91% After 2011 - 97%	-	fuel sulfur content changes removed
Workover Rig Traffic	Control percentage in the selected years Heavy Duty / Light Duty 2010 10% 5% 2015 51% 33% 2020 74% 54% 2025 84% 66% 2030 88% 73% 2037 89% 77%	Control percentage in the selected years Heavy Duty / Light Duty 2010 4% 3% 2015 28% 22% 2020 44% 34% 2025 52% 41% 2030 56% 46% 2037 60% 50%	Control percentage in the selected years Heavy Duty / Light Duty 2010 3% 4% 2015 38% 33% 2020 62% 52% 2025 76% 65% 2030 83% 73% 2037 87% 78%	Control percentage in the selected years Heavy Duty / Light Duty 2010 7% 6% 2015 53% 35% 2020 79% 54% 2025 90% 63% 2030 94% 69% 2037 96% 72%	Control percentage in the selected years Heavy Duty / Light Duty 2010 7% 6% 2015 53% 36% 2020 79% 54% 2025 90% 64% 2030 94% 69% 2037 96% 73%	Control percentage in the selected years Heavy Duty / Light Duty 2010 45% 11% 2015 76% 30% 2020 77% 36% 2025 77% 40% 2030 77% 42% 2037 78% 44%	-	Emission rates held constant at 2009 levels
Workover Rig Traffic- Fugitive Dust	0%	0%	0%	50%	50%	0%	-	Removed watering control

Source Category	Control Percentage (%)						Uncontrolled Case Engine Technology or control	Uncontrolled Case Type of Control
	NOx	CO	VOC	PM_{10}	$PM_{2.5}$	SOx		
Heaters	0%	0%	0%	0%	0%	0%	-	no change
Fugitives	0%	0%	0%	0%	0%	0%	-	no change
Pneumatic Devices	-	-	-	-	-	-	-	no change
Pneumatic Pump	0%	0%	Zero vented emissions are estimated due to flaring control. 100% of the gas stream is assumed combusted in the flare; flare combustion VOC emissions are estimated to be approximately 1% of the VOC emissions if no controls were implemented.	0%	0%	0%	none	assumed no BACT installed, 100% uncontrolled emissions
Dehydrator Venting	0%	0%	Zero vented emissions are estimated due to flaring control. 100% of the gas stream is assumed combusted in the flare; flare combustion VOC emissions are estimated to be approximately 1% of the VOC emissions if no controls were implemented.	0%	0%	0%	none	assumed no BACT installed, 100% uncontrolled emissions
Tank Loadout (vapor losses)	0%	0%	0%	0%	0%	0%	-	no change

Source Category	Control Percentage (%)						Uncontrolled Case Engine Technology or control	Uncontrolled Case Type of Control
	NOx	CO	VOC	PM_{10}	$PM_{2.5}$	SOx		
Well Venting	0%	0%	0%	0%	0%	0%	-	no change
Production Traffic	Control percentage in the selected years Heavy Duty / Light Duty 2010 10% 5% 2015 51% 33% 2020 74% 54% 2025 84% 66% 2030 88% 73% 2037 89% 77%	Control percentage in the selected years Heavy Duty / Light Duty 2010 4% 3% 2015 28% 22% 2020 44% 34% 2025 52% 41% 2030 56% 46% 2037 60% 50%	Control percentage in the selected years Heavy Duty / Light Duty 2010 3% 4% 2015 38% 33% 2020 62% 52% 2025 76% 65% 2030 83% 73% 2037 87% 78%	Control percentage in the selected years Heavy Duty / Light Duty 2010 7% 6% 2015 53% 35% 2020 79% 54% 2025 90% 63% 2030 94% 69% 2037 96% 72%	Control percentage in the selected years Heavy Duty / Light Duty 2010 7% 6% 2015 53% 36% 2020 79% 54% 2025 90% 64% 2030 94% 69% 2037 96% 73%	Control percentage in the selected years Heavy Duty / Light Duty 2010 45% 11% 2015 76% 30% 2020 77% 36% 2025 77% 40% 2030 77% 42% 2037 78% 44%	-	Emission rates held constant at 2009 levels
Production Traffic-Fugitive Dust	0%	0%	0%	50%	50%	0%	-	Removed watering control
Condensate Tank Flashing Losses	0%	0%	Zero vented emissions are estimated due to flaring control. 100% of the gas stream is assumed combusted in the flare; flare combustion VOC emissions are estimated to be approximately 1% of the VOC emissions if no controls were implemented.	0%	0%	0%	none	assumed no BACT installed, 100% uncontrolled emissions
Condensate Tank Working Losses	0%	0%	Zero vented emissions are estimated due to flaring control. 100% of the gas stream is assumed combusted in the flare; flare combustion VOC emissions are estimated to be approximately 1% of the VOC emissions if no controls were implemented.	0%	0%	0%	none	assumed no BACT installed, 100% uncontrolled emissions
Condensate Tank Breathing Losses	0%	0%	Zero vented emissions are estimated due to flaring control. 100% of the gas stream is assumed combusted in the flare; flare combustion VOC emissions are estimated to be approximately 1% of the VOC emissions if no controls were implemented.	0%	0%	0%	none	assumed no BACT installed, 100% uncontrolled emissions

Source Category	Control Percentage (%)						Uncontrolled Case Engine Technology or control	Uncontrolled Case Type of Control
	NOx	CO	VOC	PM_{10}	$PM_{2.5}$	SOx		
Production Flaring	N/A	N/A	N/A	N/A	N/A	N/A	-	-
Compressor Station	0%	0%	0%	0%	0%	0%	none	no change
	92%	84%	0%	0%	0%	0%	none	assumed AP-42 uncontrolled NOx and CO emission rates
Gas Plant	0%	0%	0%	0%	0%	0%	none	no change
	92%	84%	0%	0%	0%	0%	none	assumed AP-42 uncontrolled NOx and CO emission rates
	0%	0%	0%	0%	0%	0%	-	no change

Source Category	Control Percentage (%)						Uncontrolled Case Engine Technology or control	Uncontrolled Case Type of Control
	NOx	CO	VOC	PM_{10}	$PM_{2.5}$	SOx		
	0%	0%	0%	0%	0%	0%	-	no change
	0%	0%	0%	0%	0%	0%	-	no change
Evaporation Ponds	0%	0%	0%	0%	0%	0%	-	no change